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ALFALFA SEED PRODUCTION.

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With notes on the insect enemies of alfalfa seed by F. M. Webster, in charge of Cereal and Forage Insect Investigations, Bureau of Entomology.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., February 17, 1912.

SIR: I have the honor to transmit herewith and to recommend for publication as a Farmers' Bulletin a manuscript entitled "Alfalfa Seed Production," prepared by Messrs. J. M. Westgate, Agronomist in Charge of Clover Investigations, Roland McKee, Scientific Assistant, and M. W. Evans, Scientific Assistant, all of the Office of Forage-Crop Investigations of this Bureau, with notes on the insect enemies of alfalfa seed by Mr. F. M. Webster, in charge of Cereal and Forage Insect Investigations, Bureau of Entomology.

The recent wide extension of the culture of alfalfa in the United States has resulted in an increasing demand for seed, which has not been entirely supplied by the seed-raising districts in this country and has necessitated the importation of about 3,000,000 pounds of seed annually. Investigations indicate that with a proper understanding of the essentials for the production of seed crops the entire demand can be supplied with home-grown seed. It is therefore thought desirable that the data regarding the best-known methods of successful production of alfalfa seed be put into a form available for the use of the farmers in the alfalfa seed-growing sections.

Respectfully,

B. T. GALLOWAY,
Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

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ALFALFA SEED PRODUCTION.

INTRODUCTION.

The importance of the alfalfa-seed industry in the United States is indicated by the advance reports of the official census showing that approximately 15,829,680 pounds of seed were harvested in 1909. (Fig. 1.) The area devoted to alfalfa the same year was approximately 4,638,662 acres.

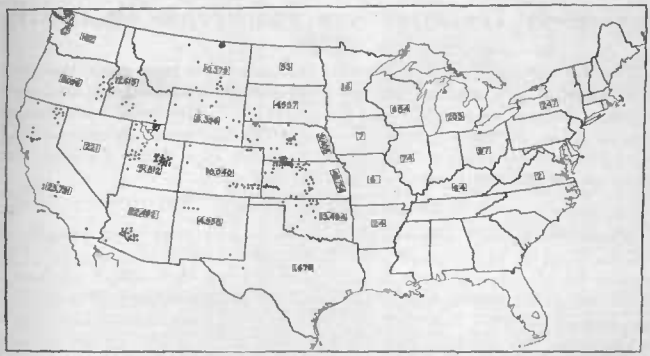

FIG. 1.—Map of the United States, showing the production of alfalfa seed in 1909. Each dot represents 1,000 bushels. The numerals indicate the production in bushels. The location of the dots indicates approximately the seed-producing areas.

The greater portion of the alfalfa acreage is reseeded on an average once in about seven years, although in some sections fields are often allowed to stand for a much longer period. In some sections the use of alfalfa in short rotations with other farm crops makes frequent reseeding necessary. In the potato and cantaloupe growing sections of eastern Colorado it is a frequent practice to hold alfalfa for only two years and then to turn it under as a green-manure crop. The land is then used for succeeding crops of cantaloupes or potatoes, which are in turn followed by alfalfa seeded with a grain nurse crop. In the East, where somewhat unfavorable conditions cause alfalfa

stands to deteriorate rapidly, reseeding every few years is necessary. Here the crop is used for forage and little or no seed is produced. Large quantities of seed are required for this reseeding as well as for the seeding of fields not previously in alfalfa. There has also been a large increase in the acreage in the West, especially on the irrigation projects which are being developed. It is thus seen that in the aggregate a large quantity of seed is annually used. The greater part of this seed is grown in the United States, but about 3,000,000 pounds are annually imported. The imported seed is an important factor in determining the price of seed in this country.

It is the province of this bulletin to treat only of the seed production of alfalfa and the factors affecting it. Other phases of alfalfa raising are discussed in separate Farmers' Bulletins, any or all of which may be secured upon application to Members of Congress or to the Secretary of Agriculture.[1]

CONDITIONS AFFECTING THE PRODUCTION OF ALFALFA SEED.

The factors of greatest importance in connection with the production of alfalfa seed are thickness of stand, soil moisture, and such climatic factors as rainfall and temperature. The local variation of one or more of these factors accounts for the great fluctuations in seed yield often observed in a given season in a single locality and even on the different parts of the same farm.

THICKNESS OF STAND.

Experiments and observations have shown that thin stands of alfalfa tend to make good yields of seed much more certain. The reason for this lies largely in the fact that the thin stand permits a more complete development of the individual plants. The greater amount of sunlight received by each plant in thin stands also tends to increase the production of seed. The accompanying illustration (fig. 2) shows the large number of seed pods produced by an isolated plant. It is a matter of common observation that isolated plants along roadsides and in fence rows ordinarily produce much heavier crops of seed than do the plants in near-by fields. Figure 3 shows the appearance of a well-set cluster of seed pods.

[1] Farmers' Bulletin 194, entitled "Alfalfa Seed," by Edgar Brown, discusses adulteration, impurities, methods of testing germination, etc. Additional details concerning methods of testing the germination and purity of alfalfa seed are given in Farmers' Bulletin 428, by F. H. Hillman.

Farmers' Bulletin 339, entitled "Alfalfa," by J. M. Westgate, contains a general discussion of alfalfa as a farm crop.

Farmers' Bulletin 373, entitled "Irrigation of Alfalfa," by Samuel Fortier, discusses methods of irrigating alfalfa as practiced in the Western States.

Circular 24, Bureau of Plant Industry, entitled "Alfalfa in Cultivated Rows for Seed Production in Semiarid Regions," by Charles J. Brand and J. M. Westgate, discusses methods of cultivation designed to combat the development of weeds.

SOIL MOISTURE.

In growing alfalfa for seed the moisture content of the soil is a most important and critical factor. It must be sufficient to enable the plant to mature its seed crop and yet not enough to induce the starting of the crown shoots in advance of the maturation of the

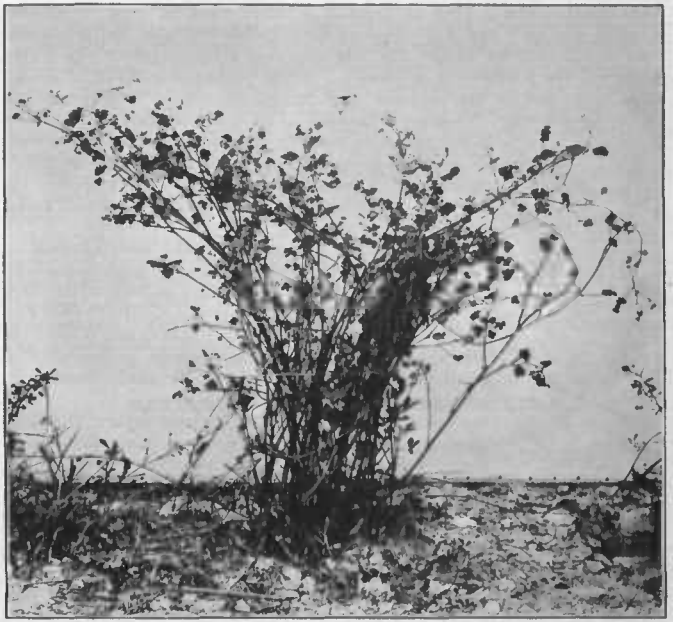

FIG. 2.—A heavily seeded isolated alfalfa plant grown near Washington, D. C., where the climatic conditions are much more unfavorable to the production of alfalfa seed than in the semiarid sections.

seed crop, as the setting of seed is often greatly lessened when the growth for the succeeding crop of stems begins. The margin between too much and too little water is a very narrow one, and it is owing more to this fact, perhaps, than to any other that alfalfa-seed production is so often uncertain.

CLIMATIC FACTORS.

That climatic conditions have an important bearing in growing alfalfa for seed is shown by the fact that successful seed crops are produced only under certain climatic conditions. The alfalfa plant requires a somewhat prolonged period of warm, dry weather to mature a crop of seed.

Rainfall.—The factor of rainfall is important in that it affects directly not only the soil-moisture conditions, but also the temperature and humidity of the air. It also has a direct effect upon the flowers if the plants are in bloom. If the period of rainfall is somewhat extended or the amount quite large, the effect is detrimental to the seed crop. An annual rainfall of at least 18 inches, properly distributed, is usually necessary for a seed crop. In such sections as eastern Kansas and Nebraska, where the normal rainfall somewhat exceeds 30 inches a year, good seed crops are obtained only in the drier years.

FIG. 1.—A well-set cluster of alfalfa pods.

Temperatures required for seed development.—It has been found that relatively high temperatures are necessary during the period when the seed crop is setting and developing. In the southwestern portion of the United States and occasionally elsewhere the extreme summer temperatures combined with hot, dry winds may, however, result in the blasting of the flowers.

Continued cool nights seriously retard the setting of the seed. Late summer or early fall frosts frequently occur in most mountain districts. These frosts have a greater or less effect on the development of any seed which may already have been set in the young, partly developed pods. Occasional light frosts seem merely to retard the development of the seed, but a severe, killing frost or continued light frosts will seriously injure the seed crop. Seed has been observed setting as late as November 13 in the vicinity of Washington, D. C., several weeks after killing frosts had occurred, but which were followed by 10 days or 2 weeks of relatively warm, growing weather.

Influence of seasonal variations in climatic conditions.—The seasonal variation in rainfall, temperature, cloudiness, etc., is of prime importance. A given section may in one season give an abundant yield only to be followed by a practical failure of the seed crop the next year, even though good hay yields may be produced. The effects of seasonal variations in rainfall can to a certain extent be offset by proper methods of planting, cultivation, etc.

INFLUENCE OF HONEY-GATHERING INSECTS.

Nearly all experiments show that if insects are excluded from alfalfa flowers by means of screens very few or no seeds are produced, whereas adjoining plants not screened produce an abundance of seed if other conditions are favorable. However, in northern Montana heavy seed crops have been obtained in certain seasons when general observations failed to indicate the presence of insects in numbers anywhere near what was considered sufficient to account for the fertilization of the flowers. The principal effect of the insects appears to be the tripping or releasing of certain of the flower parts, which operation is essential to fertilization. This tripping can be done artificially by thrusting a pencil point or other object into the flower or by pressing the flower between the thumb and finger, when the tripping can readily be observed.[1] Observations indicate that the ordinary honeybee trips the flower much less frequently than do bumblebees or some of the wild bees. The honeybee ordinarily inserts its proboscis at the side of the tripping mechanism without releasing it, while the bee's weight on the flower is not sufficient to set off the tripping mechanism as is the case with the bumblebee. The small wild bees trip the flower owing to the fact that they must struggle to reach the nectar, and in this struggling they release the tripping mechanism. Ordinarily the alfalfa flower is fertilized with pollen from some other flower, but it is able to set seed with its own pollen if the flower be tripped.

HANDLING ALFALFA FIELDS FOR SEED.

Alfalfa fields are seldom used solely for seed-producing purposes. Hay is generally the main object of planting. Seed production is more uncertain under such conditions than when the crop is seeded thinly. It is, however, possible to increase the certainty of a satisfactory seed crop even with the thicker stand by giving attention to moisture conditions, etc., as explained elsewhere. Lands under irrigation which receive seepage waters from other fields should be avoided, as should also the lower lying fields in the subhumid regions, where even a normally wet summer may cause the plants in such places to produce such a rank vegetative growth as to ruin the chances for seed.

RATE OF SEEDING.

It is a matter of common observation that isolated plants are usually heavy seed producers, while alfalfa growing near by in thick broadcasted stands may be setting little or no seed. As a rule the

[1] For a more detailed description of this process, see Circular 24, Bureau of Plant Industry, pp. 8–10.

stand should be thin enough so that there will be no crowding. Seed setting is apparently best where the stand is so thin that each plant makes a strong individual development. Sunlight appears to be a factor influencing the development of flowers and seed, and when reduced below certain limits its effect in cutting down the quantity of the seed produced is very marked. Where the stand is thin the sun can reach a surface of flower-bearing stems nearly twice as great as where the stand is so crowded that only the flowers near the top of the plant can receive sufficient light for the best development of seed. If the crop is to be used primarily for seed-producing purposes, the common practice is to seed at about half the rate customary when sown for hay. This diminution of the rate calls for 4 to 10 pounds of seed to the acre in the different sections according to differing conditions. When plants are grown in wide cultivated rows, as may sometimes be practicable, about 2 pounds of seed per acre is sufficient. This is much less seed than is required when broadcasted or when seeded in ordinary drill rows 6 or 7 inches apart. Thorough preparation of the soil, a firm, moist seed bed, and the use of a drill lessen the amount of seed necessary to be used.

Some difficulty is often experienced in adjusting an ordinary wheat drill so that it will drop the alfalfa seed thinly enough. This may in a measure be overcome by mixing some foreign material, as corn chop, sawdust, or wheat bran with the seed. It is also possible to reduce the feed by use of strips of leather in the drill feed pits. A much thinner stand can also be had by entirely stopping up two or three holes out of every four, thus making the rows 12, 18, or 24 inches apart when a 6-inch drill is used. Whatever kind of implement is used to make the seeding, it is suggested that it be first tested on bare, hard soil, with the shoes just touching the ground, as in this way it can be readily seen at what rate the seed is being dropped. The necessary regulations can then be made before the actual seeding operations commence in the field, where it is always difficult to know just how rapidly the seed is being fed into the ground. Planting in wide drills does not necessarily reduce the yield of the incidental hay crops. An experiment performed at Chico, Cal., showed that the incidental cuttings from the ordinary broadcasted stands averaged 3,169 pounds of hay to the acre, as compared with 4,191 pounds to the acre obtained from the stand in rows 18 inches apart. In this particular experiment the broadcasted stands produced no seed, while the stands in 18-inch rows gave yields as high as 124 pounds to the acre. The yields obtained from plats in which the plants were in rows 4 feet apart were even larger, as shown on page 24.

WHICH CROP TO LEAVE FOR SEED.

The crop to be left for seed should be that which will mature during the period of the best conditions as regards soil moisture and heat. In sections along the fortieth parallel of latitude where three crops of hay are normally produced it is usually customary to cut one hay crop and to let the next crop stand for seed. This method brings the seed setting in August, which is usually about the right time. In the more northern sections and at the higher altitudes farther south it may delay the second crop too long to let the first crop stand for a full cutting of hay. Under such conditions an early clipping should be made. Such clipping is beneficial in that it evens up the growth, induces uniform blossoming, and tends also to bring the setting of seed at the right time in the summer. In the Southwest, as in Arizona and the interior valleys of California, two or sometimes three cuttings of hay may be obtained before letting the crop stand for seed, but the practice is not uniform over the entire area. Better early seed crops can be obtained in Arizona and in the Imperial Valley of California than farther north. The present indications are that this is partly due to climatic conditions, but also to some extent to the attacks of the little insect called the alfalfa and clover-seed chalcis fly, which occurs most numerously early in the season in northern California, but considerably later in Arizona and in the Imperial Valley. It appears to be the rule in most sections to let what would otherwise be next to the last hay crop stand for seed. It usually takes as long for one seed crop to mature as for two crops of hay; hence, little or no growth is commonly made after cutting the seed crop, not more than is desirable for the proper protection of the plants during the ensuing winter.

FORETELLING THE SEED CROP.

If there is to be a light and consequently unprofitable setting of seed, as is often the case, it is important that such fact be known as early as possible, so that the crop may be cut at once for hay and the succeeding hay crop allowed to begin its development. If the conditions before blooming are such as to produce a rank vegetative growth it is a fairly sure indication that the chances are poor for seed. If, however, the soil becomes dry just at this time, a fair seed crop may sometimes be obtained. Also, if the blossoms appear sparingly or if they appear freely but blast or wither without setting pods, the chances for a seed crop are greatly reduced and the crop should be cut at once for hay. After this cutting another fair crop of hay may usually be secured. If, however, the cutting be delayed too long it will be at the expense of the next crop, as the time for its development

may be short. Another indication that a seed crop is likely to be very light is shown when the basal shoots begin to grow in anticipation of the succeeding crop. The development of these basal shoots takes place at the expense of seed development on the older stems.

If heavy rains occur or if continued cold, damp, rainy weather conditions prevail when the plants are in full bloom the prospects of a seed crop are greatly reduced.

The chances for seed are good if the reverse of the above conditions prevail and the plants have made a medium stocky, well-branched growth with an abundance of bloom, especially if the warm, dry conditions continue. It is practically impossible, however, to infallibly foretell the seed crop. The crop is not assured until the plants are well loaded with clusters of well-filled pods.

CULTIVATION OF FIELDS.

The vegetative vigor of alfalfa is usually increased by any cultivation which loosens up and aerates the soil. By this process a mulch

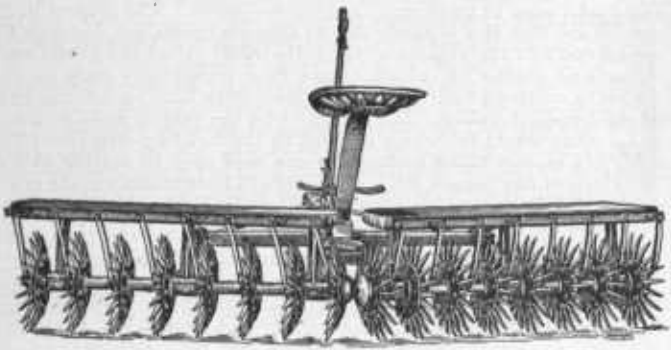

FIG. 4.—An implement for renovating alfalfa stands.

is formed which conserves the moisture. Whether this is beneficial to the seed crop depends upon the vegetative vigor of the plants at the time. Where past experience or observation indicates that the growth will be normally vigorous a light cultivation will be likely to work a positive injury to the seed crop, in that it will unduly stimulate the vegetative growth. However, on soil that becomes dry and where the plants promise to make but a light growth, an intelligent use of some such implement as a disk harrow, spring-tooth harrow, or alfalfa renovator may be utilized to overcome this condition. (Fig. 4.)

Such cultivations should be done early in the spring, before the plants start into vigorous growth.

It is sometimes the practice to run a heavily weighted disk three or four times over the field early in the spring in order to thin the stand for increased seed yields. When an ordinary plow is used it is necessary to have a very sharp share and to plow out three narrow furrows for every 8-inch width left unplowed. In addition to this it is advisible to harrow heavily later with a spike-tooth harrow in order to level down the ridges. It is also best to give some subsequent cultivation to prevent the alfalfa which has been turned under from again growing and thickening the stand. This subsequent cultivation will also serve to hold the weeds in check. (Fig. 5.)

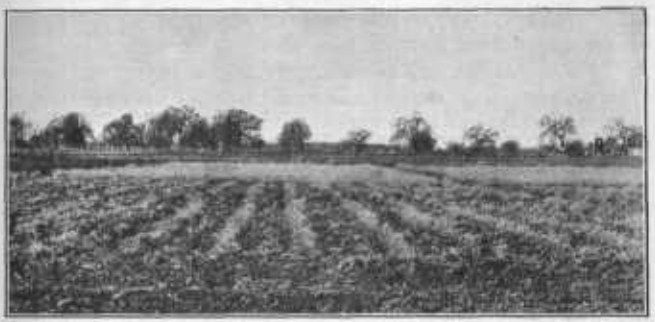

FIG. 5.—Alfalfa (originally a broadcasted stand) thinned to rows 3½ feet apart by the use of a moldboard plow.

PLANKING AND ROLLING A STAND OF ALFALFA.

It has been observed in a few instances on a small scale that rolling or planking down a stand of alfalfa just when in full bloom apparently has a beneficial effect on the seed crop. This operation might also be done with a brush drag. This effect is explainable in two ways: (1) The bending over of the stems may sufficiently retard the vegetative growth of the plants as to induce heavy seed setting. This explanation accords with observations in connection with other crops where anything that interrupts or retards the normal vegetative growth increases the setting of fruit or seed. (2) It is also possible that the tripping of the flowers that takes place when the plants are rolled has the same effect as the tripping of the flowers by insects and results in seed setting. If tripping insects are abundant in a locality the rolling of the plants might have little effect in increas-

ing seed yields, but if such insects are not numerous at the time the plants are in bloom it is obvious that rolling may be an efficient factor in causing the development of seed. It has been observed that about half the open flowers on a plant may be tripped by such an operation as rolling or planking. However, this practice needs further trial before positive statements as to its value can be made. It is suggested that the first attempts in any community be made on a small scale, and in each instance a portion of the field be left untreated to serve as a basis of comparison.

HARVESTING THE ALFALFA SEED CROP.

Considerable care is necessary in handling alfalfa for seed in order to prevent shattering. The machinery for handling a seed crop up to the time it is ready for the huller is largely the same as for hay, but for the best work some modifications are necessary.

PROPER STAGE FOR CUTTING FOR SEED.

All the pods on an alfalfa plant do not ripen at the same time, nor do all the plants in a field mature at the same time. The tendency on the part of the ripened pods to shatter often causes some loss of seed before the majority of pods mature. For this reason it is necessary to cut the crop when the greatest percentage of good seed can be saved without trying to save either the very early or the late-maturing seed. Ordinarily the crop should be cut when from two-thirds to three-fourths of the pods have turned brown. It has been found by experiments that seed gathered from pods that have turned to only a light-straw color will make a fair quality of seed although lacking somewhat in plumpness.

In order to determine the quality of seed harvested at different stages of maturity a series of experiments was made, the results of which are shown in Table I. The germination test was continued for five days and was made when the seed was about 3 months old.

TABLE I.—*Effect of harvesting alfalfa seed at different stages of maturity.*

Stage of maturity.	Percentage of seed found to be—			
	Dead.	Alive.	Hard.[1]	Capable of sprouting promptly.
Pods green and not yet fully filled out	94	6	0	6
Pods green but full size	73	27	12	15
Pods just turning from green to a light-straw color; plump	17	83	58	25
Pods turned to a light brown; plump	11	89	69	20
Pods turned brown; fully matured	9	91	68	23

[1] The so-called "hard seed" is perfectly good, but the seed coats are so hard that they are unable to take up moisture and sprout promptly. This condition disappears as the seed becomes older and is usually negligible in seed 2 or 3 years old. In sowing seed less than 1 year old the proportion of seed that will not sprout promptly should be determined and the necessary increase in the amount of seed to be sown should be provided for.

CUTTING THE ALFALFA SEED CROP.

The ordinary mower is sometimes used for cutting the alfalfa seed crop. This machine without attachments is not entirely satisfactory, owing to the shattering of the seed by the wheels and by the trampling of the horses on the succeeding round, but various devices may be attached for removing the swath from behind the cutter bar. An attachment called a "rower" or "swather," either with or without an additional bunching device, is often used. (Fig. 6.) In some sections the old-fashioned self-rake reaper is used and this implement is probably the most satisfactory for the purpose where the growth is

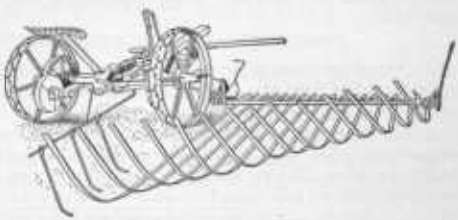

FIG. 6.—A side-delivery buncher attached to an ordinary mower; it delivers the crop to one side, out of the way of the team and machine on the next round.

FIG. 7.—A self-rake reaper. The arms, which rotate when the machine is in motion, remove the accumulated bunches of alfalfa and leave them in regular piles behind the machine.

not too heavy. (Fig. 7.) This machine has a platform or table behind the cutter bar, and the revolving rakes cast off the gavels or bunches as they accumulate. Where alfalfa is not too heavy an ordinary

grain binder can be used. These implements do away with the necessity of raking the mowed plants, an operation which usually results in much shattering of the seed but which can hardly be avoided where only an ordinary mower without some such attachment is available.

BUNCHING ALFALFA WHEN CUT FOR SEED.

In some sections it is not considered good practice to allow the cut crop to remain on the field in small bunches as dropped by a self-rake reaper or in a light swath as it would be left by a swathing attachment. When thus left there is a tendency for the seed to shatter, especially when alternately wet and dried as in the case of frequent rains or even heavy dews; consequently the cut crop is bunched with pitchforks into small shocks. The shattering incident to tearing the bunches to pieces when loading may be avoided by making them so small that each can be lifted to the rack in one forkful.

STACKING THE ALFALFA SEED CROP.

Owing to the fact that a machine to hull or thrash the cut alfalfa is not usually available immediately after harvesting, it is often necessary to stack the alfalfa to await the coming of the huller or thrasher. If the crop has been cut and bound with a self-binder and is to be stacked it is important that the bundles be left in the shock for some time, as otherwise they will be damp in the center and will be likely to heat in the stack and ruin the seed. When stacking is necessary the bunches or bundles are pitched upon hayracks with a matched-floor bottom or with a tarpaulin stretched over the bottom if it is not perfectly tight. This catches much of the shattered seed which otherwise would be lost. A foundation of hay or straw will protect the seed on the bottom of the stack and catch any seed that may shatter. No special method of stacking the alfalfa is necessary other than to keep the middle reasonably full and hard so that in case rains do occur a minimum amount of water will enter the stack. The stacks should be comparatively narrow to avoid any possible danger of heating. Care should be taken to handle the alfalfa from the rack in exactly the reverse order from that in which it was loaded so that bunches may not be pulled apart and the seed shattered. If any grass hay or even millet or sorghum be available such material should be used to top the alfalfa stacks, if there is any likelihood of rains. In the absence of such materials it may prove profitable to provide canvas covers for the stacks if rain is anticipated. These canvas covers may be spread on the ground around the machine when hulling to catch any pods or seed which may shatter.

EFFECT OF RAIN ON ALFALFA SEED.

The three principal effects of rain on the alfalfa seed crop after it is mature are: (1) Shattering of the seed; (2) discoloration of the seed;

(3) premature sprouting of the seed if the moist condition continues. For these reasons it is essential that as little rain as possible reach the alfalfa from the time it is mature until it is marketed. The germination of seed which has been repeatedly wet and dried is somewhat although not always materially reduced.

THRASHING OR HULLING THE SEED.

A regular alfalfa huller is the most satisfactory machine for hulling the seed, but many sections do not produce enough alfalfa seed to justify the purchase of such a machine. (Fig. 8.) Where these conditions exist an ordinary thrasher can be used. By screwing down the concaves and providing a special set of alfalfa sieves fairly satisfactory results can be attained. By this method a good deal of seed is left

FIG. 8.—An alfalfa-hulling scene in central Utah.

in the straw, sometimes enough to pay for running it through again. It is the custom in some parts of the country where both thrashers and hullers are used for the hullers to follow the thrashers and thrash out the alfalfa straw piles for half the seed obtained. In addition to the two methods just cited grain separators are sometimes fitted with hulling attachments. While the use of the ordinary thrashing machine has sometimes been unsatisfactory it is generally true that imperfections are due to lack of proper manipulation of the machine, but some makes of machines are better adapted than others for this work. In sections where ordinary hullers are not available there is no doubt as to the advisability of using the thrashers rather than to forego the seed crop entirely. Failure to appreciate the fact that the usual thrashing machine can be adapted to this purpose has often

resulted in the loss of a profitable seed crop in sections where seed production is not often attempted.

It is very difficult to hull alfalfa seed in damp weather or when the plants are at all moist. Hulling can be accomplished most readily when the weather is very dry and hot or when dry and very cold.

RECLEANING THE ALFALFA SEED.

Alfalfa seed as it comes from the machine is not usually in a marketable condition. It contains small stones, clods, pieces of stems and pods, and often a considerable quantity of weed seeds, as well as more or less shriveled alfalfa seed. The bulk of these impurities must be removed before the seed can be sold to advantage. A specially modified fanning mill (fig. 9) or other cleaning device will remove the lighter seeds as well as most of the portions of pods and stems, while a special set of sieves will remove the weed seeds and small stones and clods which differ in size from the alfalfa seed. As it is usually impracticable for the individual farmer to own a complete recleaning outfit, the reader is referred to page 34, where the cooperative possibilities in this matter are discussed.

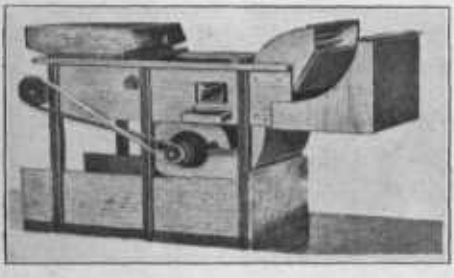

FIG. 9.—A type of fanning mill adapted to the recleaning of alfalfa seed.

UTILIZATION OF ALFALFA STRAW AFTER THRASHING THE SEED CROP.

The alfalfa straw remaining after the seed is removed is not nearly so valuable as the same quantity of alfalfa hay, but it nevertheless contains a great deal of valuable feeding material and can be used as roughage for stock. Table II gives an analysis made by the Bureau of Chemistry, showing the constituents of alfalfa straw as compared with the average of 21 analyses of alfalfa hay taken from Henry's "Feeds and Feeding."

TABLE 11.—*Composition of alfalfa straw as compared with that of ordinary alfalfa hay.*

Constituents.	Alfalfa.	
	Straw.	Hay.
	Per cent.	*Per cent.*
Water	6.26	8.4
Ash	5.13	7.4
Protein	6.75	14.3
Crude fiber	47.82	25.0
Nitrogen-free extract	32.20	42.7
Ether extract (fat)	.84	2.2

The feeding value of the straw is probably nearly half that of first-class alfalfa hay and is probably about equal, pound for pound, to ordinary grass hay. It is sometimes baled and put on the market, but ordinarily it is used as bedding or is fed as roughage to stock in the winter. It is suggested that very coarse straw be run through a feed cutter to make it more palatable to stock. Where it can not be utilized as feed it may be put back on the ground and plowed under to increase the humus content of the soil. This is a much better practice than burning the straw, as is sometimes done when no demand exists for it as feed.

SEED PRODUCTION IN DIFFERENT SECTIONS.

Probably more than two-thirds of the alfalfa seed in the country is produced in sections where the natural rainfall is too scant for the production of good yields of most cultivated crops without irrigation.

SEED PRODUCTION ON SUBIRRIGATED LANDS.

Considerable areas of land in the arid or semiarid sections of the country are supplied with water near enough to the surface so that the roots of the alfalfa may reach it and thrive in spite of the lack of rainfall. Such lands are classed as subirrigated and are important in that a deep-rooted crop like alfalfa makes them of value without artificial surface irrigation after the plants are well grown and have extended their roots down to the moist layers of soil. On lands of this class the supply of irrigating water which on other lands is necessary for the crop of the first two years is rendered available for use elsewhere on the farm. These subirrigated lands are among the best for alfalfa-seed production. The semiarid sections are usually characterized by hot summers, which are favorable to the production of seed if other conditions are right. The principal alfalfa-seed-producing lands of this type are located in Arizona, Utah, Idaho, California, Colorado, Wyoming, Montana, New Mexico, Oklahoma, and eastern Oregon. When starting alfalfa on subirrigated land it is

usually advisable, when possible, to give irrigation until the roots are able to reach the water-bearing strata below. The handling of these fields for seed production is not materially different from the methods practiced in more moist sections. The first growth may be cut for hay or clipped back to insure more nearly uniform flowering. In the southern sections a full first cutting of hay can be obtained, while in the extreme north only a very short clipping can be made, and then barely enough time may remain for the maturing of a seed crop before frosts or cold nights retard the setting of seed.

SEED PRODUCTION WITH SURFACE IRRIGATION.

Throughout the nearly arid sections of the United States where most of the alfalfa is produced with the aid of surface irrigation, considerable areas are devoted to the production of seed. Where an abundance of water is available for irrigation, and especially where there is an active demand for hay at good prices, the usual custom is to make as many cuttings of hay as possible and not rely to any considerable extent on seed production as a source of revenue. A common practice in some sections where a shortage of water for irrigation prevails during midsummer is to let the second crop stand for seed, as it is usually considered necessary to reduce the amount of irrigation given a field if it is to set its best seed crop. When alfalfa is to be raised primarily for seed in irrigated sections, a thinner seeding is advisable than if the hay crop is the prime consideration. From 15 to 20 pounds of seed is the quantity usually used when hay alone is desired, and from 5 to 10 pounds is sufficient where the stand is to be used largely for seed-producing purposes. The seeding can be either broadcast, in close drills, or in wider rows or drills. Preliminary experiments show that it may be profitable to have the rows as much as 3½ feet apart to allow cultivation the same as corn. This method is proving satisfactory in semiarid sections, where it is necessary to conserve the supply of soil moisture. It has not been thoroughly demonstrated, however, that this method can successfully compete with the more thickly seeded plants when grown under irrigation; but the high seed yield of widely isolated plants as well as that of small experimental plats under irrigation such as referred to on page 24 indicates that this method may also be of considerable value in irrigated sections, especially where there is a material shortage of water. It is seldom desirable to let a crop stand for seed during the first two years of its growth, and since it is utilized for hay during this time the stand may be thicker than would be best for seed production later. It is therefore sometimes practicable to have the stand thick and cut it for hay the first two years, after which it is thinned by the method outlined on page 13.

SEED PRODUCTION IN SUBHUMID SECTIONS.

The subhumid sections may be defined as those regions which are more moist than the semiarid sections but where summer droughts are somewhat frequent and where some care is therefore usually necessary to conserve the soil moisture if satisfactory crops are to be produced. If the semiarid sections along the fortieth parallel be defined as those having the rainfall varying from 10 to 22 inches, then the subhumid sections would comprise those where the rainfall ranges from 22 to 30 inches. Alfalfa seed can not usually be produced profitably where the annual rainfall is more than 30 inches; as a consequence, the humid sections, lying principally to the east of the subhumid sections, are not adapted to the production of alfalfa seed. The alfalfa in the subhumid sections when intended for seed as well as for hay production is usually sown broadcast in comparatively thin stands. In the seasons of severe drought, when the corn crop is practically a failure, it is not uncommon for the alfalfa fields to produce extremely large yields of seed, so that the aggregate income from a farm having a fair proportion of its acreage devoted to alfalfa may compare favorably with the income during a normal season.

ALFALFA IN CULTIVATED ROWS.

Although alfalfa is usually raised in thin broadcasted stands when seed is the main object, yet the indications are that it is sometimes an advantage to have the seeding made in rows sufficiently far apart to permit cultivation and also to insure the maximum individual development of the alfalfa plants. The yields of hay under such treatment are larger than would ordinarily be supposed, as in 18-inch rows it has been observed even to exceed the yield obtained from associated broadcasted stands. (See p. 10.) The growing of alfalfa in cultivated rows has been tried in an experimental way in many sections of the country and has in nearly all instances given promising results; but this method is not recommended for general use, except where seed is to be produced whenever seasonal conditions are favorable, since the increased expense of keeping down the weeds, especially the first year, is not justified by the returns from the hay crop.

The special feature of the possibilities of this method in the semiarid section is the fact that it furnishes a money crop for the farmer under conditions which do not usually produce maximum yields of ordinary field crops. In other words, the droughts which produce the heavy seed crops in the subhumid and humid sections, such as central and eastern Kansas, are usually an every-season occurrence in the semiarid sections. Under irrigation the seed development usually occurs at a period when there is apt to be a shortage of irrigating water, and for this reason the method promises to be very practicable

inasmuch as plantings in wide rows demand but little water for maximum yields of seed.

DIRECTIONS FOR SEEDING ALFALFA IN WIDE ROWS.

If it is not the intention to intertill the alfalfa, the rows may be a less distance apart than when it is designed to cultivate them each season. Good seed crops have been obtained from rows 8, 16, and 24 inches apart, but with the exception of the last distance it is practically impossible to cultivate between the rows after the plants have become well grown. When it is planned to cultivate during successive seasons it is necessary to seed the rows about 42 inches apart, for if planted in narrower rows little space will be available for cultivation, as the plants stool considerably. Inasmuch as the growing of alfalfa in cultivated rows is comparatively new much still remains to be developed in connection with the most suitable farm practices concerning the details of the seeding and handling of the crop. It is often possible to adapt the farm machinery already at hand to this work. It is usually practicable in sections growing corn, Kafir corn, sorghum, or milo maize to seed the rows the same distance apart as is customary for these crops. This practice permits the use of the ordinary planting and cultivating machinery in connection with the alfalfa crop.

An ordinary wheat drill can be adapted for planting alfalfa, as suggested on page 10, or a corn drill can be used if the holes are filled with Babbitt metal and then reamed out so that each will drop 6 to 10 alfalfa seeds at a time. Satisfactory results have also been obtained by using an onion-seed plate in a corn drill. A corn planter with the holes properly babbitted and reamed can be used if it is desired to have the plants in hills to permit of cross cultivation. A sugar-beet planter might also be utilized with some modifications.

PREVENTING THE DRIFTING OF SOILS.

The fact that the young alfalfa seedlings make a relatively slow growth, combined with the necessity of an exceedingly thin stand when seed production is the ultimate object, often makes difficult the prevention of the drifting or blowing of the soil for the first few months after seeding. A number of methods are available for reducing this injury, among which may be mentioned the seeding of alternate rows of grain with the alfalfa, the grain to be destroyed when the subsequent cultivations are made. Where rows of corn or sorghum are used as windbreak protection they should be made a rod apart across the field and at right angles to the direction of the prevailing winds. Where new sod is broken up, strips of the original sod left at rod-apart intervals will tend to retard the blowing of the soil. Some protection is also given by planting the alfalfa in listed furrows, leaving the ground in ridges which materially reduce the drifting of

the soil, though sometimes the winds are so heavy as to cause the plants in the furrow to be entirely covered up. A more extended discussion of the blowing of soils is given in Farmers' Bulletin 421,[1] which may be obtained free upon application to a member of Congress or to the Secretary of Agriculture.

TREATMENT OF THE STAND.

When alfalfa is seeded in wide cultivated rows the treatment the first season will be that which will most effectively hold the weeds in check and at the same time reduce as much as possible the blowing of the soil. The young alfalfa plants are ordinarily so small that it is somewhat difficult to kill the weeds by cultivation without burying

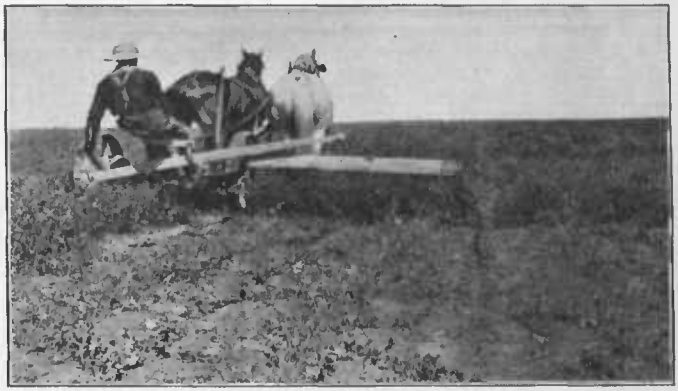

FIG. 10.—A mowing machine with dropper attachment in operation in a field of alfalfa in cultivated rows in western Nebraska. The rows in this case are one-half mile long.

the plants. This danger can in a measure be avoided by the use of properly constructed fenders, or an ordinary corn box may be attached to the cultivator, which should also be provided with narrow shovels. Unless the plants show signs of setting seed the first season it will ordinarily not be necessary to give them any attention other than the cultivation as indicated, but should the plants show signs of developing a seed crop they should be clipped back to a height of 4 or 5 inches. During the second season the first growth of the plants should be cut back not later than the time of early bloom to a height of 4 or 5 inches. Ordinarily the next growth may then be allowed to stand for seed. Figure 10 shows a field in the

[1] Farmers' Bulletin 421, entitled "Control of Blowing Soils," by E. E. Free and J. M. Westgate.

semiarid section in western Nebraska 16 months after seeding and which yielded a fair crop of seed.

During subsequent seasons little attention need be given the stand except the cultivations required to keep down the weeds and also to control properly the amount of moisture in the soil.

An ordinary corn cultivator with narrow shovels is adapted to this purpose. Very satisfactory results have also been obtained by the use of a spring-tooth harrow with some of the teeth removed so that the remaining teeth will work only the spaces between the rows.

If the plants tend to crowd each other as they become larger, cross-disking with the disks set to gouge as much as possible will assist in thinning out the plants. Cross-plowing may also prove advantageous if the use of the disk is difficult or ineffective. Where the area is not too large and plenty of labor is available a man with a grubbing hoe or mattock should be able to thin from half an acre to an acre a day if the plants are not too thick in the wide rows. This method would have the advantage of effecting the removal of the least desirable plants, leaving the rest thinned to the required intervals.

YIELDS OF ALFALFA SEED FROM CULTIVATED ROWS.

The practicability of growing alfalfa in cultivated rows for seed is to be determined in any given district by the increase in seed yield which can be obtained when compared with the yields either in thin broadcasted seedings or in narrow rows. The yield of hay possible when seeded in wide rows is usually about equal to that obtained from the broadcasted stands. For this reason the annual yield of seed is the deciding factor as to whether or not the increased expense of cultivating the alfalfa in rows is justified. Yields as high as 9 bushels to the acre have been obtained without irrigation in the semiarid sections from plants which had been specially selected for heavy seed production. Yields as high as 5 bushels to the acre are not uncommon.

In an experiment at Chico, Cal., under a single light irrigation, one-tenth of an acre in rows 4 feet apart, the third year from planting yielded at the rate of 458 pounds per acre, as compared with 215 pounds from the stands which were 2 years old.

ALFALFA IN CULTIVATED ROWS IN IRRIGATED SECTIONS.

The method of growing alfalfa in cultivated rows for seed was developed principally under dry-land conditions in the semiarid sections; but test plats have shown that increased yields of seed are possible even under irrigation, and for that reason it is suggested that this method be given at least a trial in the seed-producing irrigated sections of the country. The actual results obtained from

row seedings as compared with broadcasted stands are shown on pages 10 and 24.

ALFALFA IN CULTIVATED ROWS IN SUBHUMID SECTIONS.

Tests of alfalfa in cultivated rows for seed-producing purposes have not been made in subhumid sections on a scale sufficiently large to warrant definite statements concerning its probable success. There are in many sections, however, areas of upland or thin, naturally dry soils which on account of their nature really present conditions of soil moisture comparable with the semiarid sections of the West. On such areas it is probable that the seeding of alfalfa in wide rows would be a practicable undertaking.

ALFALFA IN CULTIVATED ROWS IN SEMIARID SECTIONS.[1]

The special advantage of the semiarid sections for alfalfa-seed production lies in the fact that the conditions of relative drought during the seed-developing period combined with the high midsummer temperatures bring about an approach to the ideal conditions for the production of maximum crops of seed. By the cultivations rendered possible under such conditions the moisture supply in the soil can be regulated within certain limits and sufficiently conserved for the proper development of the plant and the production of profitable crops of seed. The general statements already made concerning alfalfa in cultivated rows will apply to the semiarid sections, but some attention must be given to the selection of the soils that will provide as nearly as possible the desired conditions of moisture during the growing seasons. In the very dry sections the lower lying soils must be utilized and it may even be desirable to select such soils as will receive a considerable portion of the run-off from adjoining areas.

When rains occur in the semiarid sections they are often too light or fall too fast to wet the ground to any considerable depth. Under such conditions the amount of moisture received into the ground is insufficient for best results from alfalfa even when utilized for a seed crop. Any method of handling the land that will tend to make it take up more of the rain water is desirable. If a nearly level field is available which can be made to receive the run-off water of a considerable area it may be practicable to open up surface ditches that will lead the run-off to this field, which should also be ditched to receive the water in event of rain. When the above suggestions can be carried out the efficiency of many of the rains could be greatly increased. It would be desirable, however, to provide for diverting the run-off flood waters when enough has run over the field.

[1] For a more detailed account of the growth of alfalfa in cultivated rows for seed production in semiarid sections, see Circular 24 of the Bureau of Plant Industry, entitled "Alfalfa in Cultivated Rows for Seed Production in Semiarid Regions," by Charles J. Brand and J. M. Westgate.

In the less dry sections the lands lying between the lower and the upland soils may be utilized for alfalfa-seed production. In the more moist portions of the semiarid regions and even in the subhumid sections the upland soils will more nearly provide the desired moisture conditions in an average season.

The preparation of the seed bed in semiarid sections also needs special attention, because it is usually necessary to conserve the moisture for some months or even a year or more in advance of seeding in order that an abundant supply may be available for the rapid early growth of the plants. Rapid early growth will enable them to compete with the drought-resisting weeds, which are quite certain to develop and cause trouble if the alfalfa plants are stunted by the lack of sufficient soil moisture during their first season of growth. This conservation of moisture is best brought about by surface tillage and proper packing of the subsoil.

ALFALFA SEED COMPARED WITH HAY AS A MONEY CROP.

It is seldom that any section grows alfalfa exclusively for the production of seed, although there are many sections in which it is utilized for hay only. Where a strong demand exists for alfalfa hay at good prices there is always the temptation to cut the crop for hay, as much less risk is then incurred and a very profitable return is ordinarily secured. The time required to develop a seed crop is at least twice that necessary for a crop of hay. Consequently two crops of hay must be sacrificed to produce one crop of seed and straw. The production of hay makes more profitable the utilization of the large outlying sections of summer-grazing land, from which cattle and sheep can be driven to the alfalfa stacks for winter feeding; but when for any reason it is difficult to dispose of the alfalfa hay, it then becomes advisable to give attention to seed production if it is at all feasible. In some of the more recently settled sections of the West more alfalfa hay has been produced than could be profitably utilized, owing to the shortage of stock to which it could be fed; neither could it be profitably shipped out, owing to the long railway-freight hauls. In other sections so far removed from the railroads that long hauls by teams are necessary, the production of alfalfa hay has been rendered much less profitable than it is in many other alfalfa sections. In such sections as those just mentioned the production of alfalfa seed offers special advantages, because the seed usually commands a good price and can be transported at a relatively small expense. At 12½ cents a pound a ton of alfalfa seed is worth $250 as compared with about $10 for a ton of hay. It is obvious that the product of an acre of alfalfa utilized for seed is much more easily transported than the product of an acre cut for hay. Furthermore, if the hay is sold from

the farm a great deal of fertilizing material is removed and lost to the farm. When a seed crop is produced only a small amount of fertilizing material need be removed from the farm, since the straw or manure produced from it can be again returned to the land and plowed under.

Table III indicates in a general way the relative cost of production and returns from an acre of alfalfa left to stand for seed in comparison with the two cuttings of alfalfa hay which are ordinarily procurable in the same length of time. The figures given show that any excess over 200 pounds of seed produced will make the seed production correspondingly more profitable than hay. If the seed yield falls below 200 pounds per acre it becomes less profitable than the two hay crops, the returns from which vary but little. It will be noted that only the cost of the farm operations appear in this table, the rent of land, etc., being assumed to be the same in both cases.

TABLE III.—*Estimated relative returns from alfalfa hay crops and seed crop.*

Item.	Rate for single operation, per acre.	Cost of production and returns from an acre of alfalfa when utilized for—			
		Hay (two crops, 3 tons, at $10 a ton).		Seed (one crop, 200 pounds, at 12½ cents a pound).	
		Cost.	Return.	Cost.	Return.
Mowing	$0.50	$1.00		$0.50	
Raking	.20	.40			
Stacking	1.50	3.00		1.50	
Baling	3.00	6.00			
Thrashing	6.00			6.00	
Cleaning	2.00			2.00	
Hauling hay	2.25	4.50			
Hauling seed	.40			.40	
Total		14.90		10.40	
Value of product			$30.00		$25.00
Net profit per acre			15.10		14.60

ALFALFA SEED YIELDS.

The ordinary yield of an alfalfa field allowed to stand for seed ranges from 2 to 5 bushels per acre. Many yields run as low as 1 bushel per acre and even less, but yields of much less than 1 bushel are not usually considered worth thrashing or hulling. On the other hand, authentic records show rare instances when 18 to 20 bushels of clean seed have been obtained from an acre of ground. Such yields, however, are due to a very fortunate combination of circumstances which seldom recur in a particular community. In one rather large seed-producing locality the average for the entire section was over 10 bushels per acre the first year that seed was allowed to set on large areas. In the two years following these remarkable yields large

acreages left standing for seed resulted in almost universal disappointment because the crop averaged probably less than a bushel per acre for the entire locality. Full seed crops are usually not to be expected until the third year, as the older alfalfa plants have deeper root systems which can utilize moisture and plant-food materials unavailable to younger plants.

CONTINUED CROPPING TO SEED AND ITS EFFECT ON ALFALFA PLANTS.

It is often considered much harder on the vitality of the alfalfa plant to produce a crop of seed than to produce a crop of hay, and for this reason some farmers hesitate to let a crop stand for seed every year, even when conditions are favorable for seed production. The data at hand, however, show instances of fields which have produced as high as five or six cuttings of seed in as many years and which are yielding just as satisfactory crops of hay as other near-by stands which have produced but one or two crops of seed during the same period. Individual plants as well as entire plats left standing for seed in experimental tracts have been observed to show a more vigorous growth the succeeding season than those cut throughout the season for hay. It would appear from the somewhat meager data that the one seed crop is even less injurious to the plants than the two cuttings of hay which would otherwise be removed during the same period of time. It is quite probable that the injurious effects which have been observed to follow heavy seed crops are not due primarily to the effect of the seed crop, but rather to drought or other conditions adverse to the vegetative growth of the plants and which induced the heavy production of seed.

DRAWBACKS TO THE SUCCESSFUL PRODUCTION OF ALFALFA SEED.

A very severe drought may prevent the plants from making sufficient growth to give much seed-producing surface or to fill the seed if they are set. A continued series of cloudy days, even though no rain may fall, may have an adverse effect on the setting of seed. The occurrence of continued cold weather will also seriously affect the setting of a good seed crop.

None of the disturbing factors noted are as a rule controllable, but strong individual development of the plant, such as is obtained in thin stands, tends to enable the plant to develop seed under somewhat adverse conditions and makes the limitations of seed production much less restricted than where the plants are crowded and strong development of the individual plants is prevented.

INSECT ENEMIES OF THE ALFALFA SEED CROP.

THE CLOVER-SEED CHALCIS FLY.

The clover-seed chalcis fly (*Bruchophagus funebris* Howard), received its common name from the fact that it was first observed attacking the seed of red clover. It has, however, become of even greater importance as an enemy of alfalfa seed than it has of clover seed. In fact, it was in all probability originally introduced into this country from Europe or Asia in alfalfa seed. In distribution it covers almost if not quite the entire United States, occasionally becoming so numerous as practically to destroy the entire seed crop. This condition has been known to exist when the owner of the field did not even suspect the attack of insects of any kind. The egg of the chalcis fly is laid in the developing seed before it is hardened and while yet in an almost jellylike mass inclosed within a thin envelope. The larva developing from the egg feeds within this seed, which is incapable of supplying food for more than one individual. Passing its entire transformation from egg to adult within the seed, it makes its way forth precisely as in the case of red clover; that is, it eats a hole in one side of the seed and gnaws a corresponding hole in the pod through which it emerges. If the alfalfa is promptly thrashed the seed may still contain many of these insects which have not emerged from the seed. Later on these small black wasplike insects (fig. 11) may be seen crawling over the seed. Whether or not the insects are observed the small hole in the side of the seed or pod is an indication that they have been present. According to the observations of Roland McKee the damage can be reduced more or less by having the seed crop develop if possible at the time when there are fewest chalcis flies. This time can be determined in the different localities by noting the extent and time of maturity of their host plants. In sections where the bur clovers (*Medicago* spp.) are common the chalcis is most abundant at the time of maturing of the seed of this crop and the damage to alfalfa seed maturing at the same time or soon after is great. In sections where bur clovers are not common the wild clovers (*Trifolium* spp.) and alfalfa in waste places afford the most common

FIG. 11.—Adult form of the clover-seed chalcis fly (*Bruchophagus funebris*) after emerging from an alfalfa seed. The wings ordinarily are closely folded along the back. (Greatly enlarged.)

breeding places. By keeping the alfalfa cut from the roadsides, along fences, and in other waste places where it ordinarily seeds undisturbed, the number of chalcis flies will at least be reduced. In most localities outside of the bur-clover districts the earlier in the season an alfalfa seed crop can be harvested the less will be the damage. In southern localities the earliest bloom produces little seed. This insect is more fully discussed in Circular 69 of the Bureau of Entomology, United States Department of Agriculture.

GRASSHOPPERS.

Many species of grasshoppers attack and do serious injury to alfalfa throughout almost the entire region of its cultivation. Perhaps the yellow-winged locust, *Camnula pellucida* Scudder, is the most common depredator in the West. The eggs of grasshoppers are laid in the ground in late summer in podlike sacks. They are deposited almost entirely in uncultivated lands. These eggs hatch the following May or June and in about a month the young grasshoppers become fully developed and winged so that they can migrate.

There are two popular methods of destroying these insects. One method is to collect them in shallow pans known as hopperdozers. The other method is to use poisoned baits. The most effective bait is known as the Criddle mixture, composed of 1 pound of Paris green, or some other convenient arsenical, and 2 pounds of salt thoroughly mixed with 60 pounds of fresh horse droppings. This bait is scattered among the young insects or around the edges of fields which it is thought may be invaded. A very convenient receptacle in which to make this preparation is a barrel cut in half. A trowel or paddle can be used in scattering the mixture where desired. Another poison mixture is composed of 1 pound of Paris green to 50 pounds of bran moistened to a stiff dough with sweetened water. Either of these poisons scattered among grasshoppers proves a very attractive bait and effectually disposes of any grasshoppers partaking thereof.

THE ALFALFA CATERPILLAR.

The larvæ or caterpillars of a very common yellow and black butterfly (*Eurymus eurytheme* Boisd.) occasionally become excessively abundant especially in the southwestern portion of the country, effectually destroying not only the first cutting but succeeding cuttings also, thus making the production of seed impossible. The results of investigations which have been carried on by the Bureau of Entomology (see Circular No. 133) seem to indicate that a larger part of the damage can be prevented by cutting the alfalfa at a time when the caterpillars are young and thus deprive them of their food supply, which results in their death. In irrigated sections the water should be applied as soon after cutting the hay crop as possible.

THE ALFALFA WEEVIL.

The insect known as the alfalfa weevil (*Phytonomus posticus* Gyll.) is about the size of a grain of wheat, brown in color, with a long slender snout, much like the plum curculio. Imported from the Eastern Hemisphere it has become established in the region of country near Great Salt Lake, Utah, whence it has spread into southern Idaho and western Wyoming. It has proved a most destructive pest of alfalfa and the production of seed has been impossible in the localities where it has occurred. (Fig. 12.) It is being investigated in order to find some means of preventing or reducing its ravages. These measures have consisted of the application of mechanical devices for destroying the young weevils in the fields, destroying the adults in their hibernating places, and the introduction of its natural enemies into this country from Europe, where they seem to effectually prevent serious injuries from its attacks on alfalfa. A more detailed account is given in Bulletin 112 of the Bureau of Entomology, United States Department of Agriculture, entitled "Preliminary Report on the Alfalfa Weevil," by F. M. Webster.

FIG. 12.—Adult form of the alfalfa weevil (*Phytonomus posticus*): Adults clustering on and attacking a spray of alfalfa. (Slightly enlarged.)

WEEDS AFFECTING THE ALFALFA SEED CROP.

Weeds constitute a rather serious menace to the successful production of alfalfa seed. They not only crowd the plants in the field but their seeds are harvested with the alfalfa seed and are thus often sold with it and carried to other sections. In this way they spread with possible damage to the farms on which the seed is sown.

The problem of weed destruction in alfalfa stands is difficult. Alfalfa is less aggressive than many weeds. The alfalfa plants do not spread by runners or rootstocks as do many of the grasses, while old alfalfa stands ordinarily do not thicken up from self-sown seed,

as is the case with most of the weeds. The weeds in an alfalfa field tend to increase more rapidly when the stand is allowed to remain for seed each year than when the field is mown regularly for hay. When this weedy condition develops, a year or two of regular mowing for hay will do much toward reducing the number of weeds present in the field.

The dodders or "love vines" (*Cuscuta* spp.) are among the worst weeds with which the alfalfa plant must contend. The dodder seed is often introduced into the alfalfa field with the original seeding. The seed of the large-seeded dodder is so nearly the same size as the alfalfa seed that it is almost impossible to screen it all out, even with the most carefully constructed sieves. The dodder plant itself is a yellow threadlike vine which attaches itself to the alfalfa plant. (Fig. 13.) It often destroys the seed-producing capacity of the plant which it attacks and matures its seed so as to be harvested with the alfalfa seed.[1]

FIG. 13.—A mature dodder plant on an alfalfa stem.

The wild barleys (*Hordeum* spp.), often called foxtail in the Western States, seriously affect the first cutting of alfalfa, but since these weeds grow principally in the cooler portions of the year they affect the seed production only indirectly. The true foxtails (*Chaetochloa* spp.) and crab-grass (*Syntherisma sanguinalis* (L.) Dulac) prove troublesome in the subhumid sections, as in central Kansas, while the Russian thistle (*Salsola kali rosacea* Pall.) is at times very troublesome in the semiarid sections, especially in thin stands or where the alfalfa is being grown in wide cultivated rows. The Russian thistle seeds are with difficulty removed from the alfalfa seed, although some of the seed-cleaning devices founded on the inclined canvas roller

[1] See Farmers' Bulletin 306, entitled, "Dodder In Its Relation to Farm Seeds," by F. H. Hillman.

system are said to be efficient in removing them. They are about the same size as the alfalfa seed but of different shape. (Fig. 14.)

In most of the Rocky Mountain seed-growing sections wild mustard (*Brassica* sp.), the cheat grasses (*Bromus sterilis* L. and *B. secalinus* L.), and sweet clovers (*Melilotus alba* Desr. and *M. officinalis* (L.) Desr.) are quite troublesome. Star thistle (*Centaurea solstitialis* L.) is more or less troublesome in the alfalfa seed-growing sections of the Southwestern States, but its seeds are less difficult to separate from alfalfa seed than those of the other weeds mentioned, and therefore its menace is less serious.

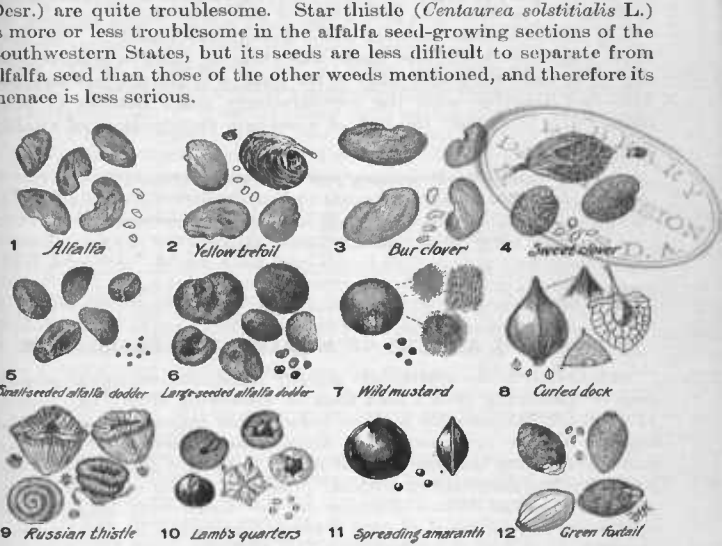

FIG. 14.—Seeds of alfalfa and common adulterants and impurities. (Enlarged and natural size.)

ADULTERATION OF ALFALFA SEED.

After alfalfa seed leaves the farm and enters the market it is sometimes adulterated by unscrupulous dealers with other less valuable seeds closely resembling alfalfa. Bur clover and yellow trefoil are the principal adulterants. When buying alfalfa for seeding it is important to examine the seed for such adulterants, as well as for other weed-seed impurities. This precaution is of special importance when the prospective planting is to be utilized for seed production. The methods of testing alfalfa seed for adulterants and impurities as well as for germination are fully discussed in other Farmers' Bulletins.[1]

[1] See Farmers' Bulletin 194, entitled "Alfalfa Seed," by Edgar Brown, and Farmers' Bulletin 428, entitled "Testing Farm Seeds in the Home and in the Rural School," by F. H. Hillman.

LONGEVITY OF ALFALFA SEED.

Alfalfa seed retains its vitality for a comparatively long time. Seed 2 or 3 years old is practically as good for planting as fresh seed. This makes it possible to carry the seed over a year or more in case it should become necessary. The results of germination tests are given in Table IV, in which the percentage of good seed shown includes the "hard seed" as well as that which germinates readily.[1] The seed upon which the tests were made was obtained from various sources and no doubt varied somewhat in the quality of the original samples. This fact together with the comparatively small number of tests made tends to explain the lack of a uniform deterioration of vitality as age increases.

TABLE IV.—*Percentage of good alfalfa seed at different ages.*

Item.	Age of seed in years.									
	1	2	3	4	5	6	7	8	9	10
Number of tests	5	7	4	11	9	8	7	5	5	5
Percentage of good seed	93	84	70	63	68	71	48	41	65	44

COMMERCIAL ASPECTS OF ALFALFA SEED PRODUCTION.

In addition to the statements already made concerning the greater ease of marketing alfalfa seed than of marketing alfalfa hay, owing to its much less bulk for a given value, other important commercial aspects deserve consideration. Among these problems is that of suitably cleaning the seed so that it will command good prices when it reaches the distributing centers. The seed of any one community is usually bulked before shipping to the distributing centers, and unfortunately the grade of seed is often determined by the presence of a few poor lots of seed among those of higher grade. For this reason it is very important that the seed of any given section be reduced as nearly as possible to a uniform basis before entering the ordinary channels of trade. At present this is done to a certain extent by local merchants, some of whom install machines with which they clean the seed either before or after purchasing it from the individual farmers. It is suggested that a cooperative arrangement among different farmers might result in a more satisfactory solution of these somewhat difficult problems of hulling, cleaning, and marketing the seed. With cooperation once started it need not be confined to cleaning and marketing the seed crop to the best advantage, but

[1] See footnote on page 14.

might be extended to the undertaking of cooperative experiments on the individual farms to determine the best of several possible methods of handling the seed crop in their particular section. With a number of farmers trying different treatments on their fields, experience could be obtained in one season which would otherwise require a number of years to procure. This plan of cooperation could also be utilized in the establishment of some trade variety of seed. A premium could be commanded for such seed if it was of good quality, and especially if of a variety in strong demand in some particular section of the country. The extreme northern seed-producing sections might take up the production of a hardy strain such as the Grimm alfalfa, an unusually hardy variety which has been grown for over fifty years in the severe winter climate of Minnesota. The demand for this variety will for years probably far exceed the supply. Farmers located in the southwestern part of the country with equal advantage might undertake the production of the Peruvian alfalfa seed, which is obtained only in very small quantities and with great difficulty in South America. When once established this variety produces satisfactory seed crops in the milder sections of California and Arizona. In the same manner farmers in the semiarid sections could determine by preliminary experiments the most valuable strain for their sections of the country and could then develop this strain so that it would have a recognized superior value on the market. Since large quantities of seed are annually imported to meet the increasing demand it is probable that it will be some years before the home-grown supply will equal the demand.

The lowest price of the season usually prevails shortly after the hulling season is over. Better prices could be obtained if means were at hand for holding the seed until the desired price was secured. If a cooperative association were organized in a proper manner, each member could store his seed in the association's warehouse and, if desired, receive an advance of at least two-thirds the market value of his seed in cash at a nominal rate of interest pending the time he decided to sell his seed.

SUMMARY.

The increasing demand for alfalfa seed has not been entirely met by the home-grown supply; as a result, large quantities of seed are annually imported. It is entirely possible for the American farmer to produce all the seed required for use in this country, but the many uncertainties in connection with the production of the seed crop have often deterred growers from letting their fields stand for seed. The principal alfalfa seed-producing sections are those where a relative

shortage of water exists during the time that the seed crop is maturing and where the temperatures at this time are comparatively high. Profitable seed crops are produced in the subhumid and semiarid sections of the Great Plains area without irrigation and in the semiarid and arid districts farther west either with subirrigation or partial surface irrigation. Seed production in rows is giving promise of success. It is of utmost importance in all sections that the stand should be thin. The extremely large yields of alfalfa seed produced under specially favorable conditions not generally understood or even recognized indicate the possibilities in connection with seed production when the conditions favoring maximum seed crops are fully realized.

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